

STORAGE AREA NETWORK MANAGEMENT SYSTEM, METHOD, AND
COMPUTER-READABLE MEDIUM

CROSS REFERENCE TO RELATED APPLICATIONS

The contents of Japanese Patent Application No. 2000-167482, filed June 5, 2000 in Japan, are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the invention

The present invention pertains to the management systems of storage area networks (hereafter referred to as SAN) that join several servers and several storage devices using fiber channel networks.

2. Description of the Related Art

In recent years, the capacity of single storage systems has increased and they now need to be able to function with several different types of servers. Also, with the advent of the widespread use of fiber channels, which can transfer data in parallel along data transfer routes at high speeds and among

several host computers, it is expected that the scale of the connection format of storage systems is going to become even larger in this environment.

Joining several servers and several storage devices together in this way is referred to as a storage area network (hereafter referred to as a SAN) and attempts are being made to reduce the total cost of ownership (TCO) or manage the storage needs of several servers that are increasingly dispersed.

Be that as it may, however, there are some problems that require solving in the areas of security and the management of regions on a storage device.

One of these problems is that it is possible for data in one storage device that is being used by one host to be inadvertently destroyed by another host when a SAN is made up of several host computers (hereafter referred to as hosts) and several storage systems. This is because all of the hosts are capable of accessing all of the storage systems.

At present there are no perfect solutions to the problems of managing regions in storage systems or security. Moreover, when there is a problem with one of the many devices making up a SAN, many different error reports are sent to the system administrator, making it difficult to pinpoint an affected area and resulting in no real method for doing so.

Several terms used herein are well known in the art. More particularly, SAN (storage area network), FCA (fiber channel adapter), HBA (host bus adapter), WWN (world wide name), PID (port identification), and TCO (total cost of ownership) are terms which are well known in the art.

SUMMARY OF THE INVENTION

The present invention solves the above-mentioned problems.

An object of the present invention is to integrate and manage the traditionally dispersed security system from a single source.

Another object of the present invention is to provide good security administration automatically in a storage area network (SAN).

The present invention comprises a storage area network management system, method, and computer-readable medium storing a program executing processes.

The storage area network management system, method, and computer-readable medium of the present invention comprise host computers, storage devices, switches, and an integrated management mechanism. Each of the host computers comprises a storage area network management mechanism. Each of the storage devices comprises a storage management mechanism. The switches are coupled to the host computers and to the storage devices. The switches interconnect the host computers and the storage devices. Each of the switches comprises a region-setting mechanism. The integrated management mechanism integrates and controls the storage area network. The integrated management mechanism includes access route information of the host computers and the storage devices and, based on the access route information, transmits access management information to the storage devices and the storage area network management mechanisms of the host computers, transmits region information to the region-setting mechanisms of the switches, and transmits access limit information concerning the host computers to the storage management mechanisms of the storage devices.

Moreover, the storage area network management system, method, and computer-readable medium of the present invention comprises the integrated management mechanism detecting whether fiber channel adapters mounted on the storage devices and the host computers, the host bus adapters mounted on the host computers, or the switches in the storage area network management system are replaced, obtaining settings information following the replacement

from the storage area network management mechanism of the host computers, the switch region-setting mechanism, or the storage device storage management mechanism, and reconfiguring the access relationships to be equivalent to the access relationships prior to the replacement.

5 In addition, the storage area network management system, method, and computer-readable medium of the present invention integrates problem reports from related problems into a single problem report.

Further, the present invention comprises a method of a storage area network system comprising integrating and controlling the storage area network by an integrated management mechanism managing access relationships between host computers of the storage area network and storage devices of the storage area network.

These together with other objects and advantages which will be subsequently apparent, reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic diagram of the present invention.

20 Fig. 2 is a diagram showing a typical SAN system configuration suitable for the present invention.

Fig. 3 is a diagram showing the configuration of the SAN management system of one embodiment of the present invention.

25 Fig. 4 is a diagram showing a typical storage device hardware configuration.

Fig. 5 is a diagram showing examples of access pass settings

21

information, a storage affinity table, a switch, a zoning table and a host affinity table.

Fig. 6 is a flowchart showing the process performed by the SAN integrated management mechanism of the present invention.

Fig. 7 is a flowchart showing the process performed by the zoning settings mechanism.

Fig. 8 is a diagram describing a SAN problem management.

Fig. 9 is a diagram showing a typical problem report method definition.

Fig. 10 is a flowchart of the SAN problem monitoring function performed by the SAN integrated management mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a schematic diagram of a Storage Area Network Management system 100 of the present invention. As shown in Fig. 1, the Storage Area Network Management system 100 of the present invention installs in a SAN environment, an integrated management mechanism 1 of the present invention that integrates and controls the SAN so that all of the access relationships of the hosts 2 and the storage devices 4 are managed using the integrated management mechanism 1. The system administrator sets up the regions on the storage device 4 side that are to access the integrated management mechanism 1 from the host 2 side as well as the fiber channel adapter (FCA) and host bus adapter (HBA) to be used when accessing that storage. These settings are referred to as the access paths.

Based on the access path information that was set up, this integrated management mechanism 1 first establishes the storage settings (or Storage affinity) that is seen from the host 2 side by the SAN management mechanism 2a on the host 2 side.

Then, the system administrator establishes the zoning for the switch 3 zoning setting mechanism 3a by securing the World Wide Name (WWN) and Port Identification (PID) information that the FCA and HBA have and then makes calculations that allow the access paths that were set up based on that information to be configured. Next, the settings are made in the storage management mechanism 4a of the storage device 4, to determine which FCA is to permit access to which HBA (WWN or PID) and to which regions.

As above, installing the integrated management mechanism 1 makes it possible to conduct comprehensive security management and storage region management in a storage area network system.

Also, by setting up the above integrated management mechanism 1 so that the integrated management mechanism 1 holds the SAN configuration status as the configuration setting information 1a, it is easy for the SAN to accommodate hosts that do not have SAN management functions or switches that do not have zoning devices, allowing for as much security as possible.

Furthermore, by installing the aforementioned integrated management mechanism 1 the following functions become possible:

(1) Integrated management mechanism 1 secures the SAN configuration status from individual devices and stores that as configuration settings information 1a. Then, either at regular intervals or when given a command by a system administrator, the integrated management mechanism 1 reads in the current SAN configuration status and compares that with the SAN configuration settings information 1a. If they differ, the integrated management mechanism 1 determines that there is a problem and notifies the system administrator. This makes it easy for system administrators to be able to learn about SAN problems.

(2) When given the command from the system administrator, the

integrated management mechanism 1 secures access relationships information from the SAN management mechanism 2a, the zoning settings mechanism 3a and the storage management mechanism 4a, and checks the compatibility of the access paths. If the access paths are not set up correctly, the integrated management mechanism 1 notifies the system administrator as to where the problem is. This makes it possible for the system administrator to verify the compatibility of the access paths.

(3) When the host 2, the host 2 HBA, the switch 3 or the FCA of the storage device 3 are replaced, the aforementioned integrated management mechanism 1 detects this, obtains the settings information after the replacement from the host 2 SAN management mechanism 2a, the switch 3 zoning settings mechanism 3a, or the storage management mechanism 4a of the storage device 4, and reconfigures the access relationships so that they will be equivalent to those prior to the replacement. This makes it possible to respond easily to modifications in the SAN configuration easily.

(4) When the access paths are not set up when the system is first brought up, the settings to switch 3 are configured such that no access is allowed. This makes it possible to avoid settings which allow accidental access when the system is first started up and no access paths have been set up.

(5) In the fiber channels, there are fiber channel transfer class parameters for which the HBA and FCA sides are to be set up with shared settings. If these parameters are different on the HBA side and FCA side, transfers will be impossible.

For this reason, when setting up the aforementioned access paths, the transfer class to use is specified by the system administrator and, through the SAN management mechanism 2a, the storage management mechanism 4a, the integrated management mechanism 1 is set up so that the access paths set by the

HBA and the FCA operate using the same transfer classes. This allows the elimination of the problem of being unable to transfer data when the transfer classes differ.

5 (6) When a problem occurs inside the SAN, first, the integrated management mechanism 1 receives a report of that problem and temporarily stops sending reports to the system administrator. It then waits for a specific period of time to see if there have been any reports from any of the other devices managed by the integrated management mechanism 1. It checks the content of any reports received during this waiting period against the WWN, 10 PID and access path information of each adapter that the integrated management mechanism 1 holds and checks for a possible relationship to the problem reported first. If it is determined that there is a relationship, only one problem is reported to the system administrator. Based on this information, the system administrator can determine immediately the problem area.

15 (7) It doesn't just report on one affected area. Even reports where the affected area has been judged to be unrelated in a report may be reported as a related problem. This makes it possible for the system administrator to determine the scope of the effect.

20 (8) The integrated management mechanism 1 secures not only settings information for each of the access paths in advance, it also secures logical volume information on the host 2 side that is used on each access path as well as information from the SAN management mechanism 2a on the host 2 side and stores it as the configuration settings information 1a of the integrated management mechanism 1. When a problem is reported in the SAN, the 25 integrated management mechanism 1 reads in the configuration settings information 1a in the integrated management mechanism 1 for the access path using the affected spot and reads the host logical volume using that access path

and reports the logical volumes affected by the trouble to the system administrator. Once the logical volume affected by the problem is known, the recovery of that logical volume can be started immediately and the effect on business operations can be kept to a minimum.

5 Embodiments of the Present Invention

Fig. 2 shows an example of a SAN system configuration 200 that could be used with the present invention discussed with reference to Fig. 1. As shown in Fig. 2, the LAN (local area network) 210 in which many host computers (hereafter referred to as hosts) H1 ~ Hn, management servers S which function as SAN comprehensive management devices (discussed below), the aforementioned switches SW1 ~ SWm, the storage devices ST, and the magnetic tape devices MT are connected.

The SAN 220 (storage area network) is equipped with the hosts H1 ~ Hn, the switches SW, the storage devices ST, the magnetic tape devices MT and other devices. There are data paths among the various hosts H1 ~ Hn, the switches SW1 ~ SWm, the storage devices ST and the magnetic tape devices MT. Access between the hosts H1 ~ Hn to the storage devices ST and other devices has priority over the data paths. The information showing the configuration status of the SAN 220 is also transferred by the storage device ST over the LAN to the management server S and all of the settings information that comes from the management server S is transferred to the host computers H1 ~ Hn, the switches SW and the storage devices ST.

Fig. 3 is a diagram showing the configuration of the storage area network (SAN) 200 of the embodiment of the present invention. Here, as an example, the SAN 200 includes the hosts 110 and 120, the switch 300 and the storage devices 410 and 420.

In Fig. 3, the hosts 110 and 120 are connected to the switches 300 by the fiber channel 303, 304 through the host bus adapters (hereafter referred to as HBA) 111, 112 and 121. The storage devices 410 and 420 are also connected to the switches 300 by the fiber channel adapters (hereafter referred to as FCA) 411, 412 and 421.

Fig. 4 shows an example of a hardware configuration of a storage device 430 corresponding to one of the storage devices 410, 420 shown in Fig. 3. In the storage device 430 shown in subsystem control module 11 is connected to upper devices 130, 132 (such as host devices 110, 120) through channel I/F modules 134, 136. The subsystem control module 11 includes a memory 11a, an MPU 11b and a bus interface module 11c. The aforementioned MPU 11b runs programs stored in the memory 11a. In addition to programs, transfer data and control data are also stored in the memory 11a.

Device control module 13 includes buffer 13a, MPU 13b and memory 13c. Memory 13c stores programs that run on the aforementioned MPU 13b and bus interface module 13d.

The aforementioned subsystem control module 11 and the device control module 13 are connected to each other through the bus 138. The device control module 13 is connected to the disk drive group 15 through the device I/F module 14.

In the SAN environment described above, the management mechanism 500 (corresponding to the management server S in Fig. 2, mentioned above, which includes this function) which integrates and controls the SAN, was installed in this embodiment as shown in Fig. 3. The embodiment of SAN 220 is set up so that the management mechanism 500 can manage the access relationships between the hosts 110 and 120 and the storage devices 410 and 420, as shown in Fig. 3.

The SAN management mechanisms 118 and 128 are also installed on the hosts 110 and 120 and the storage management mechanisms 418 and 428 are installed on the storage devices 410 and 420 in order to respond to control from the management mechanism 500.

As described above, the SAN management mechanisms are mechanisms that set up the storage affinity; also as described above, the storage management mechanisms are mechanisms that set up the host affinity. The switch zoning settings mechanism 301 is installed on the switch 300

The system administrator sets up the region on the storage side that attempts to access the SAN integrated management mechanism 500 from the host side and the FCA (fiber channel adapter) and the HBA (host bus adapter) that are used when accessing that storage. These settings are referred to as the access path settings.

In this SAN integrated management mechanism 500, the access path information that has been set up is stored as access path settings information 600 in the SAN integrated management mechanism 500 shown in Fig. 5 (a). Using this settings information, the storage settings (Storage affinity) that can be seen from the host side are set up on the SAN management mechanisms 118 and 128 on the host side. That is, they are set up to determine which FCA (WWN or PID) can be accessed from which HAB.

The settings specifying which FCA can be accessed from which HBA are organized by creating a management table in the host like the storage affinity 602 shown in Fig. 5 (b) and specifying the FCA to be accessed. In this example, the settings allow access to region 415 in the FCA of WWN c from HBA 111. The command on the fiber channel can be run through the WWN of the destination FCA.

The WWN and PID information held by the FCA and HBA is secured in

advance in response to the zoning settings mechanisms 301 of the switches 300. Calculations are made so that the access paths originally set up are configured and the zoning is set up. Fig. 5 (c) shows an example of a switch zoning table 604.

5 The zones here are set up using A and B and the identifier (here WWN) of the ports (HBA or FCA) that permits mutual access is stored in the respective zones. In this way, Zone A is recognized for access from the switch WWN a and an access restriction which only allows operations to be run on WWN c is put in place.

10 In the fiber channel environment, when the switches 300 and the ports are connected, a log-in sequence begins and the switch is able to secure WWN information as part of that log-in sequence. When commands are issued from the hosts 110 and 120 to the storage devices 410 and 420 using this information, if the access of a port that has not been specified for the zone is designated, the system control prevents the command from reaching the storage devices 410 and 420.

15 Next, the access settings are set up to determine which regions will be permitted access to the storage management mechanisms 418 and 428 of the storage devices 410 and 420 from which HBA or PID of the storage devices 410 and 420. Fig. 5 (d) shows a sample host affinity table 606.

20 Based on this table 606, only access from the HBA of the WWN a will be allowed to region 415 for FCA 411 and only access from the HBA of the WWN e will be allowed to region 416 for FCA 412.

25 In a fiber channel environment, there is a log in sequence in which mutual port information is exchanged before accepting a command from a host. The WWN, PID and other destination information are verified during that sequence.

Here, the FCA determines whether or not access is permitted of the destination information of the WWN or PID that has been secured. The processing will continue only for devices permitted access. Access attempts by those without permission will result in check condition or other error responses.

5 There are some devices that have no SAN management mechanism among the host devices making up the SAN. There are also devices which do not provide the aforementioned host affinity function even inside the storage device. For this reason, the management mechanism 500 would not designate the access relationships for this sort of device, but the security would be assured by other security systems (such as Storage affinity or zoning).

10 Fig. 6 is a flowchart 650 showing a specific example of the operation of the SAN integrated management mechanism 500. The processes shown in Fig. 6 are stored on a computer-readable medium storing an integrated management program which, when executed by a computer, causes the computer to execute the processes shown in Fig. 6.

15 First, the SAN integrated management mechanism 500 reads in the FCA, the WWN of the HBA and the PID (Process 652). In the example in Fig. 3, the SAN integrated management mechanism 500 would recognize that the HBA 111 of the host 110 was WWN a and PID a, that the FCA 411 of the storage device 410 was WWN c, PID c and the FCA 412 was WWN d and PID d.

20 Next, the SAN integrated management mechanism 500 would accept the FCA scheduled for access from the HBA and its subordinate regions (Process 654). In the example in Fig. 3, it would accept the path settings for access to the region 415 through the FCA 411 of the storage device 410 from the HBA 111 of the host 110.

25 Next, the host in question would check to see if the storage affinity function were supported or not (Process 656). If the storage affinity function is

not supported, control would pass to Process 660. If the storage affinity function is supported then in Process 650, the storage affinity function would allow the SAN integrated management mechanism 500 to use the PID or the WWN to set up the devices (Process 658) that can access the host side SAN management mechanism from the HBA.

For example, in the example in Fig. 3, the SAN management mechanism 118 is set up so that it can access the WWN c or the PID c that are the identifiers of the FCA 411 of the storage device 410 from the HBA 111 of the host 110.

Next, it will check to see if the switch supports the zoning function (Process 660). If the zoning function is not supported, it will go on to Process 664. If the zoning function is supported, the zoning settings mechanism of the switch establishes the zoning function to use WWN or PID in Process 662.

In the example in Fig. 3, for instance, the access to the FCA 411 of the storage device 410 from the HBA 111 of the host 110 would be either the WWN a ~ WWN c zoning settings or the PID a ~ PID c zoning settings. One of those would be set to the zoning settings function 301 of the switch 300.

Next, there is a check to determines whether the storage device supports the host affinity function (Process 664). If the host affinity function is not supported, the process ends. If the host affinity function is supported, then, in Process 666, the host affinity function is used to set up the relationships between the region and the PID or the WWN of the host-side HBA that is permitted access from the FCA.

For example, the example in Fig. 3 is set up so that commands from the PID a or the WWN a of the host 110 HBA 111 are accepted by the FCA 411 of the storage device 410. Also, the storage management mechanism 418 of the storage device 410 is set up so that it can access the region 415 in response to

commands from either the WWN a or the PID a.

Next, the flowchart 700 in Fig. 7 describes operations performed by the zoning settings mechanism 301 in the switches 300.

First, the zoning settings mechanism 301 is set to a state without zoning settings (a mode which permits communications among all ports) (Process 702). That is, the standard is that no zones are set and that all access is permitted.

Next, the zoning settings mechanism 301 accepts a non-permission setting for communications among all ports from the SAN integrated management mechanism 500 (Process 704), which sets it up so that communications among no ports is permitted (Process 706). By setting it up in this way so that no communication is permitted among ports, the problem of accidental access when the system is started up and no access paths have been specified can be avoided.

Next, the zone settings (the PID groups or the WWN groups, making up the zone) are accepted from the SAN integrated management mechanism 500 (Process 708). These zone settings are made, for example, by the system administrator through the SAN integrated management mechanism 500.

New zone settings are made for the zoning settings mechanism 301 using the WWN groups or PID groups accepted above (Process 710).

Next, the switches 300 secure the WWN of the destination ports connected to each of the ports (Process 712). Note that the PID is determined by the position of the physical port of the switches 300.

Here, when the command is issued from the host port WWN x to the destination port WWN y, the switch 300 accepts the aforementioned command (WWN x \rightarrow WWN y) (Process 714). Then, the zoning settings mechanism 301 checks to see if WWN x and WWN y are set for the same zone (Process 716). If they are set for the same zone, the command passes from the host port to the

destination port. That is, the destination port is made recognizable using the name server function of the switch 300 (Process 718). And, if the settings are not for the same zone, the command is not allowed to pass. That is, the destination port recognition is deleted using the name server function of the switch 300 (Process 720).

Next, the fundamentals of the host input/output process (I/O operations) in the SAN environment described above are described.

The following is a description (using Fig. 3 mentioned above) of a typical process in which an I/O operation issued from the host 110 and 120. Note that this description concerns the I/O to the storage devices 410 from the host 110 through the HBA 111, the switch 300 and the FCA 411.

First, from the storage affinity table shown in Fig. 5 (b) mentioned above, the host 110 recognizes that the region 415 access requires accessing the FCA with a WWN c through the HBA 111.

Based on this information, the host 110 issues a fiber channel frame to the HBA 111 switch 300 as the I/O for WWN c.

The I/O fiber channel frame is secured for the WWN c accepted from the HBA 111 of the switch 300 and access is permitted because the WWN c and WWN a of the HBA 111 are in the same zone on the switch zoning table shown in Fig. 5 (c) mentioned above. The fiber channel frame is transferred to the FCA 411 that is specified by the WWN c value.

The fiber channel frame received from the FCA 411 is recognized as having come from WWN a which is designated in the host affinity table in Fig. 5 (d) mentioned above, so it determines that it can process this and runs the I/O.

The following is a description of the functions of the SAN integrated management mechanism 500 above.

(1) Detection of System Problems by Comparing the SAN Configuration

Settings Information

As stated above, the SAN integrated management mechanism 500 secures SAN configuration information from each of the devices and stores that in the SAN configuration settings information 501.

5 The SAN integrated management mechanism 500 also reads in the current SAN configuration information at regular intervals or when instructed by a system administrator, compares that with the SAN configuration settings information 501 and notifies the system administrator if it determines that there has been a problem. For example, in the state in Fig 3 above, the SAN configuration settings information 501 was registered and then the storage device 420 power supply went out. The SAN determines that there was a problem with the configuration and reported to the system administrator that the storage device 420 could no longer be seen.

(2) Access Path Match Verification

10 When given a command by the system administrator, the SAN integrated management mechanism 500 secures the access relationships information from the SAN management mechanisms 118 and 128, the zoning settings mechanism 301, the storage management mechanism 418 and 428 and verifies that the access path(s) match.

15 If the access paths are not set up correctly, the system administrator will be notified of a problem in that section. This function makes checking for problems possible if a system administrator has gone and changed the settings on individual equipment.

20 Also, if the SAN is already in a state where the access paths have already been set up, when the SAN management logic is incorporated anew, the existing SAN access paths can be checked to see if they are set up correctly.

(3) Reconfiguring the Access Relationship Settings for HBA Replacement

When the HBA 111 on the host 110 side fails and is replaced with a new HBA, the SAN management mechanism 118 detects the HBA replacement and notifies the system administrator. Using the new configuration settings command from the system administrator, the SAN management mechanism 118 reports that a new HBA WWN was replaced in the SAN integrated management mechanism 500.

The SAN integrated management mechanism 500 uses the new WWN to re-establish access relationships that are equivalent to those prior to the HBA replacement. It then sets up the access relationships once more in two mechanisms that set up access relationships (Zoning settings mechanism 301 and the storage management mechanism 418).

(4) Reconfiguring the Access Relationship Settings for Host Replacement

When the host 110 fails and is replaced with a new host, the SAN management mechanism 118 on the host 110 detects that the settings are gone and notifies the system administrator. Using the new configuration settings command from the system administrator, the SAN management mechanism 118 reports that a new HBA WWN has been connected to the SAN integrated management mechanism 500 and the SAN integrated management mechanism 500 uses that WWN to establish access relationships that are equivalent to those prior to the HBA replacement. It then sets up the access relationships once more in two mechanisms that set up access relationships (Zoning settings mechanism 301 and the storage management mechanism 418).

(5) Reconfiguring the Access Relationship Settings for Switch Replacement

When the switch 300 fails and is replaced, the system detects that the zoning information that was set in the switch is missing and notifies the system administrator.

A reconfigure settings command from the system administrator

establishes a mechanism in the SAN integrated management mechanism 500 that will set the access relationships for the new switch to those prior to the failure. In this case, the access relationships in the new switch will be reset by the SAN integrated management mechanism 500 to those prior to the failure.

5 Note that when the switch 300 fails and is replaced, the absence of zoning information that was set up for the switch will be detected, but the system can be configured so that instead of sending a notice out to the system administrator, a mechanism can be built into the SAN integrated management mechanism 500 that automatically sets up the access relationships in the new switch to those prior to the failure from the SAN integrated management mechanism 500.

10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
220

switches are set up so that they are not permitted any access when the system is brought up without the access path settings.

Without such settings, all of the hosts would be able to access all of the SAN storage and that could cause problems of security.

5 (8) Setting up the Fiber Channel Transfer Classes

Fiber Channels (FC) have parameters referred to as FC transfer classes for which the settings should be shared on the HBA and FCA sides. The transfer classes in this system range from 1 ~ 3, and transfer class 1 is used sparingly. Transfer class 2 returns an acknowledge following the transfer and transfer class 3 does not return an acknowledge following the transfer. If these parameters on the HBA and FCA sides are different, transfers cannot take place.

That is why when setting up the access paths discussed above, the classes to be used are specified by the system administrator and the management mechanism 500 is set up to run on the same classes specified for the access paths specified for the HBA and FCA throughout the management mechanisms 118 and 128 and the storage management mechanisms 418 and 428.

The following is a description of the aforementioned SAN trouble monitor using the SAN integrated management mechanism 500.

The method used is basically that when using the SAN integrated management mechanism 500, when there are problems with the devices making up the SAN (hosts, switches and storage devices), the SAN integrated management mechanism 500 receives all reports of device problems from the device side and reports them to the system administrator.

However, as shown in Fig. 8, when there is a problem with FCA 411, not only does the storage device 410 send a report to SAN integrated management mechanism 500 that the FCA 411 has failed, the switch 300 sends out a report that either the FCA 411 or the switch port connected to the FCA

411 has malfunctioned and a report that the access paths from the host 110 side and from the HBA 111 cannot be used.

It follows that a method is needed for compiling the problem reports from these three places into one report for the system administrator. This method is described below.

When there is a problem in the SAN, first the SAN integrated management mechanism 500 receives a report of that problem and then stops reports to the system administrator for a time. That is, the SAN integrated management mechanism 500 waits for a specific period of time (for example, one minute) to see if any other problems are reported from other devices that the SAN integrated management mechanism 500 manages.

While the SAN integrated management mechanism 500 is waiting, the SAN integrated management mechanism 500 reviews the content of the problem report that the SAN integrated management mechanism 500 received and the SAN integrated management mechanism 500 starts checking the WWN, PID or the aforementioned access path information held in the SAN integrated management mechanism 500 for each of the adapters to see if there might be something related to the first problem received.

If a related problem is found after the check, it follows the problem report method definition 800 shown in Fig. 9 that is set up in advance in the SAN integrated management mechanism 500 and reports just one problem to the system administrator. Using this information, the system administrator can determine where the affected point is immediately

Fig. 9 shows an example of the problem report method definition 800. Fig. 9, the column on the left shows the problem information that the SAN integrated management mechanism 500 received and the column on the right shows the content of the problem report made up by the SAN integrated

management mechanism 500.

For instance, if the SAN integrated management mechanism 500 receives the following problem reports: FCA error, switch port access error and host-side access error, the SAN integrated management mechanism 500 will judge it to be an FCA error and send out a problem report.

The following is a description of the SAN problem-monitoring function of the SAN integrated management mechanism 500 and an example of the FCA 411 problem report method based on the flowchart 1000 in Fig. 10.

First the SAN integrated management mechanism 500 receives a problem report (Process 1002). If, for example, the problem took place in the FCA 411, the SAN integrated management mechanism 500 would receive an FCA 411 problem report from the storage device 410.

Based on this, the SAN integrated management mechanism 500 would wait for a specific period of time to see if there were problem reports from other devices (Process 1004).

If the SAN integrated management mechanism 500 receives a problem report from the switch side (Process 1006), the SAN integrated management mechanism 500 would compare the content of the new problem report against the earlier problem report based on related information from the WWNs and other devices (Process 1008). For example, if the SAN integrated management mechanism 500 received a report that there were path errors with the WWN c and PID c from the switch 300, the SAN integrated management mechanism 500 would recognize that they were the same error because the WWN c and PID c are part of the FCA 411.

Next, when a problem report is received from the host side (Process 1010), the content of the new problem report is compared against the content of the earlier problem report based on related information from the WWN and

5 other devices (Process 1012). If, for example, a report about a WWN a and
PID a path error is received from the host 110, the SAN integrated management
mechanism 500 is aware that the WWN a and PID a as well as the WWN c and
the PID c are linked to the access path 600, so they will be recognized as the
same problem.

10 After the aforementioned wait for a specific amount of time (Process
1014), the related information is compared and the fundamental cause of the
problem is determined (Process 1016). This determination of the fundamental
cause is performed using the aforementioned problem report definition contained
in the SAN integrated management mechanism 500. For example, based on the
aforementioned problem report definition, a problem on the host side and a
problem on the Switch 300 side would be judged to be an FCA problem on the
storage side.

15 Only the fundamental cause is reported to the system administrator once
it has been determined (Process 1018). For example, for the aforementioned
problem with the FCA 411, only the FCA 411 problem would be reported to the
system administrator.

20 In the foregoing description, only the affected area was reported, but the
system could be set up so that reports on problems that were not judged to have
been related may also be reported with the related problems. In this way, the
scope of the effect of the problem can be determined by the system
administrator.

25 If the SAN integrated management mechanism 500 also secures the host-
side logical volume information used in the access paths from the SAN
management mechanism 118 in addition to the settings information for each
access path and stores that in the SAN configuration Settings information 501,
the SAN integrated management mechanism 500 reports which logical volumes

have been affected by the problem and report that to the system administrator.

That is, if problems are reported from inside the SAN 220, the access paths using the affected point are read in by the SAN integrated management mechanism 500 from the SAN configuration settings information 501 in the SAN integrated management mechanism 500. Furthermore, the host logical volumes using the access paths are also read in and the affected host logical volumes are reported to the system administrator as well. For example, for a problem with the FCA 411, region 415 would become unusable.

If the system administrator can figure out the logical volumes affected by the problem, the recovery of those logical volumes would be possible immediately, keeping the effect on business operations to a minimum.

A storage area network system of the present invention includes several computers and several storage devices forming a storage area network connected by switches. The aforementioned storage area network is equipped with an integrated management device that integrates and manages said storage area network. In addition to being equipped with access path information of the host computers and storage devices, the integrated management device also sends out access management information to the storage area network management mechanism of the host computers and to the storage devices, region information to the region setting mechanisms of the switches, and access restriction information concerning the aforementioned host computer to the storage management mechanisms of the storage devices. When the fiber channel adapters which are mounted on the storage devices, the host computer, the host bus adapters which are mounted on the host computers or the switches in said storage area network management system are replaced, the aforementioned integrated management mechanism detects this, obtains the settings information following the replacement from the storage area network management

mechanism of the host computers, the switch region-setting mechanism or the storage device storage management mechanism and reconfigures the access relationships so that they are equivalent to those prior to the replacement.

5 In addition, in the storage area network system of the present invention, when the host bus adapter of the host computer fails and is replaced, the integrated management mechanism detects the replacement of the host bus adapter and notifies the system administrator. The system administrator issues a reconfigure command and the integrated management mechanism passes along the settings information from the new, replacement host bus adapter in the storage area network management mechanism of the host computer. Using the new settings information, it configures the access relationships to be equivalent to those prior to the replacement of the host bus adapter and reconfigures the access relationships of the storage area network management mechanism, the region-setting mechanism and the storage management mechanism.

10
15
20 Moreover, in the storage area network system of the present invention, when the host computer fails and is replaced, the integrated management mechanism detects that the storage area network management mechanism of the host computer has no settings and notifies the system administrator. The system administrator issues a reconfigure command, which passes along to the integrated management mechanism the settings information of the connected host bus adapter. The integrated management mechanism uses that information to reconfigure the access relationships to be equivalent to those prior to the host computer replacement and then sets up the access relationships of the region-setting mechanism and the storage management mechanism once again.

25 Also in the storage area network system of the present invention, when a switch fails and is replaced, the integrated management mechanism detects that the region settings information that was set up in the switch is not present and

notifies the system administrator. The system administrator issues a reconfigure command, which sets the access relationships prior to the replacement in the new switch and can reconfigure the access relationships.

Further in the storage area network system of the present invention, when a switch fails and is replaced, the integrated management mechanism detects that the region settings information that was set up in the switch is not present and the integrated management mechanism automatically sets up the access relationships prior to the failure in the new switch and then reconfigures the access relationships.

In addition in the storage area network system of the present invention, when the storage device side fiber channel adapter is replaced and the fiber channel adapter settings information is changed, the integrated management mechanism detects this and notifies the system administrator. The system administrator issues a reconfigure command and the storage management mechanism passes along the new settings information to the integrated management mechanism. The integrated management mechanism uses that new settings information to reconfigure the access relationships so that they are equivalent to those prior to the replacement and then configures once again the access relationships of the storage area network management mechanism and the region management mechanism.

Also, a storage area network system of the present invention includes several host computers and several storage devices connected by switches and is equipped with an integrated management mechanism that integrates and controls the above storage area network. The integrated management mechanism is equipped with the access path information of the host computers and storage devices and using said access path information, the integrated management mechanism sends out access management information to the storage devices and

to the storage area network management mechanism, and the integrated management mechanism sends out region information to the switch region-setting mechanisms and sends out access restriction information concerning the aforementioned host computers to the storage management mechanisms of the storage devices. In this storage area network management system, when the system is started up and the access path information has not been set up, the aforementioned integrated management mechanism first sets up the region-setting mechanisms of the switches so that no access is permitted and after that, the integrated management mechanism sets up the regions on the regions settings mechanisms of the switches.

Further, a storage area network system of the present invention includes several host computers and several storage devices connected by switches and is equipped with an integrated management mechanism that integrates and control the above storage area network. The integrated management mechanism is equipped with the access path information of the host computers and storage devices and, using the access path information, the integrated management mechanism sends out access management information to the storage devices, region information to the switch region-setting mechanisms, and access restriction information concerning the above host computers to the storage management mechanisms of the storage devices. In this storage area network management system, the above integrated management mechanism sets up the specified fiber channel transfer classes using the storage area network management mechanism of the host computers whose access information has been set up, and the storage management mechanism of the storage devices. This makes the host bus adapters of the host computers and the fiber channel adapters of the storage devices operate using the same transfer class.

Moreover, a storage area network system of the present invention

includes several host computers and several storage devices connected by means of switches and is equipped with an integrated management mechanism that integrates and control the above storage area network. The integrated management mechanism is equipped with the access path information of the host computers and storage devices and, using said access path information, the integrated management mechanism sends out access management information to the storage devices and the storage area network management mechanisms, region information to the switch region-setting mechanisms, and access restriction information concerning the above host computers to the storage management mechanisms of the storage devices. In this storage area network management system, when a problem occurs in the storage area network system the above integrated management mechanism receives problem information and, for a specified period of time, the integrated management mechanism waits to see if there are other problem reports. The integrated management mechanism checks the problem reports received during that period and investigates the relationship between them and the problem report received first. If the integrated management mechanism judges that they are related, the integrated management mechanism sends out a single report concerning just one affected area according to a problem report method definition set up in advance in the aforementioned integrated management mechanism.

In addition, the storage area network system of the present invention presents the related problem reports that it receives as related problems in addition to the single problem area.

Further, in the storage area network system of the present invention, in addition to the settings information for the access paths, the above integrated management mechanism also obtains and holds host-side logical volume information used in the access paths from the host computer storage area

network management mechanism. When there is a report of a problem from within the storage area network, said access paths are used to read in the logical volume based on the access path information using said problem area, and report on the logical volumes that are affected by the problem.

5 Effects of the Present Invention

As described above, in the present invention, the SAN is equipped with an integrated management mechanism that integrates and controls storage area networks and the integrated management mechanism above keeps track of all of the access relationships between the hosts and storage devices making the following effects possible.

- (1) It is possible to configure a highly reliable SAN system that is administered from one place. It is also compatible with past systems that lack host affinity, zoning or other functions, so it is not necessary to purchase an entirely new system in order to provide an operating environment for configuring a SAN.
- (2) It is possible to check problems with SAN and the compatibility of access paths easily.
- (3) The hosts, HAB , switches, storage devices, FCA and other components making up the SAN may be replaced or the SAN configuration may be changed and easily accommodated.
- (4) If there is a problem with the SAN, the affect area and the scope of its effect can be determined easily, so the effect on business operations can be kept to a minimum.

The many features and advantages of the invention are apparent from the detailed specification and, thus, it is intended by the appended claims to cover all such features and advantages of the invention which fall within the true spirit

and scope of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation illustrated and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

5

10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100

Element Number List

| | | |
|----|----------|---|
| | 1 | Integrated Management Mechanism |
| | 1a | Configuration Settings Information |
| | 2 | Host |
| 5 | 2a | SAN Management Mechanism |
| | 3 | Switch |
| | 3a | Zoning Settings Mechanism |
| | 4 | Storage Device |
| | 4a | Storage Management Mechanism |
| 10 | 14 | Device I/F Module |
| | 100 | Storage Area Network Management System |
| | 110, 120 | Host |
| | 111, 112 | Host Bus Adapter (HBA) |
| | 121 | Host Bus Adapter (HBA) |
| 15 | 130 | Upper Device |
| | 132 | Upper Device |
| | 134, 136 | Channel I/F Module |
| | 138 | Bus |
| | 200 | Storage Area Network System Configuration |
| 20 | 210 | Local Area Network |
| | 220 | Storage Area Network |
| | 300 | Switch |
| | 301 | Zoning Settings Information |
| | 303, 304 | Fiber Channels |
| 25 | 410, 420 | Storage Device |
| | 411, 421 | Fiber Channel Adapter (FCA) |
| | 412 | Fiber Channel Adapter (FCA) |

| | |
|----------|--|
| 418, 428 | Storage Management Mechanism |
| 500 | SAN Integrated Management Mechanism |
| 501 | SAN Configuration Settings Information |

CONFIDENTIAL